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THE INTERNATIONAL TELEGRAPH CONFERENCE.

ON Tuesday, the 10th inst., will assemble, under the auspices of the Postmaster-General, the first international telegraph conference held in England.

The adherence by Government to the international treaty or convention in force at the time it purchased the inland lines of the United Kingdom, carried with it, among other things, the obligation of providing for such conferences as the present whenever London should be selected as the place of meeting; and the fact that London has been so selected, on almost the first occasion which has arisen since, will, no doubt, be felt as a compliment to the country.

The last international telegraph conference was held in 1875, at St. Petersburg, and was attended by delegates from the telegraph administrations of the governments of Germany, Austria, and Hungary, France, Great Britain, India, Italy, Russia, Turkey, Spain, Belgium, Holland, Dutch East Indies, Roumania, Sweden, Denmark, Egypt, Norway, Switzerland, Greece, Portugal, Servia, Luxemburg, and Persia; each administration being entitled to one vote, although represented in several cases by more than one delegate. The delegates were, with few exceptions, the heads of the administrations of the contracting governments; and, in addition to the delegates, the St. Petersburg conference was well attended, as had been the previous conference at Rome, by representatives from the chief English telegraph companies, who were invited to a place at the table, to make known their views upon all questions discussed, but without the power of voting.

The procedure to be adopted is usually settled by each conference at its first or second sitting, but that followed at St. Petersburg will presumably serve generally as the model for the constitution of the London conference. There will, however, probably be more delegates than on previous occasions, as additional governments have signified their intention to take part in it, amongst which may be mentioned some of our own colonial governments, the Brazils, and perhaps Japan. The representatives from the companies are also likely to be more numerous than at St. Petersburg or Rome.

The gathering will, therefore, be an important one, and will have for task the revision of the international regulations and tariffs of nearly all the telegraph lines of the world, the only exception of consequence being the lines of America which are in the hands of private companies; but even these will be affected by the modifications which may be made, as in practice the American companies find themselves obliged to treat all messages exchanged with Europe in general accordance with international usage.

A copy of the St. Petersburg convention which the delegates have to revise is now before us. Its French text and English translation in parallel columns, occupy about 80 closely printed pages of foolscap folio, and the document is divided into three sections. The first section is in the form of a treaty, and deals chiefly with the political side or general principles of international telegraphy. Thus it recognises the right of all persons to make use of the lines, reserves on the part of each government the power of interrupting the service on its own territory, or stopping messages dangerous to public security or contrary to law, defines the order of precedence among the principal categories of messages, declares the limits of governmental liability specifies the bases for the formation and modification of tariffs, &c.

The second section is the *pièce de resistance*, containing all the working regulations necessary to give effect to the articles of the treaty and many more besides. The extent of the details embraced by it may be gathered from the fact that it deals with the size or carrying capacity of the principal wires, the kinds of instruments employed, the component parts of all the letters, figures, and signs used in signalling, the subdivision of messages, from the three treaty categories of government, service, and private, into classes of plain, secret, multiple, urgent, repeated, insured, press and telegraph cards, with the appropriate treatment and charge for each; the subsidiary arrangements for replies, official acknowledgments of receipt, the interchange of messages with ships at sea by semaphores, their re-despatch from delivery offices, to follow the addressees to different places or countries, corrections by telegraph, &c. It regulates, also, the hours of duty at the different offices, the power of diverting messages from given routes, the conditions of stopping those contrary to law, the measures to be taken on the occurrence of interruptions, the selection of an international monetary unit for the preparation of tariffs and accounts, the amount which may be collected from the public of each country as the equivalent of this unit, the adjustment of traffic accounts, the payment of balances, the re-imbursement of charges, the duties of the international office, &c.

The third section contains the international

tariffs, arranged under the twenty-word standard for Europe, and the single-word standard for extra Europe. They are composed chiefly of one or two mean terminal rates and one or two mean transit rates for each country. They include also the charges of concessionary companies where necessary.

From the foregoing outline of the three sections, it will be recognised that the task of revising an international telegraph convention is by no means a light one, especially as each administration of the contracting Governments has the right to put forward as many proposals as it pleases for altering any of the working regulations or tariffs. The first alterations for consideration at the London conference were compiled and printed, and circulated by the international office at Berne early last year, it being then thought that the conference would be held in 1878. It was postponed till now in consequence of the unsettled state of Europe, and a book of supplementary proposals has lately been issued. The aggregate proposals fill several hundred large quarto pages and would occupy several days to read and perhaps several weeks to thoroughly study.

An international telegraph conference is however a very fair place to illustrate the doctrine of the survival of the fittest. Owing to the number of parties interested, a multitude of proposals must of necessity come before it for consideration; but from the criticism and wide experience brought to bear upon them, those which pass the ordeal, and finally emerge in the form of new regulations or rates, are generally very few. It is therefore probably safe to predict that the present convention of St. Petersburg which has worked well for upwards of three years will not be materially altered in revision, except, perhaps, in the two important matters of European tariffs and the alteration of the message standard. We understand that the German administration has strong proposals on both these points, and it is possible that the London conference may be remembered as having swept away the old twenty-word system of charging in Europe and substituted a cheap single word rate in its place.

Each conference has hitherto specially associated itself with some useful step in advance, or with the more prominent of the measures passed by it. Thus the first Paris conference of 1854 is remembered by its original well devised rules, which, so far as they go, have served as the basis of all subsequent rules. The second Paris conference of 1865 is remembered by its abolition of the plan of charging by mileage and its introduction of mean rates for each country. The Vienna conference of 1868, by its great reductions in tariffs, its creation of a ten-word message standard for extra Europe, and the establishment of an international office. The Rome conference of 1872, by its addition of a word standard to the ten-word minimum for extra Europe, its recognition of various other exceptions beyond European limits, and its provision for the leasing of lines to the press, the St. Petersburg conference of 1875, by its introduction of a word standard pure and simple for extra Europe, a mean tariff between Europe on one side and India on the other, and its creation of the telegraph card at reduced rates. Should the London conference now succeed in so far reconciling the numerous interests concerned as to give us a cheap word rate throughout Europe in place of the present twenty-word standard, its title to honourable recollection will not be inferior to that of any of its predecessors.

It is usual for a Minister of State to open each conference by a speech to the delegates, in which he welcomes them, wishes them success in their labours, and finally places them under the presidence of the head of the telegraphs of the country. Thus at Vienna, Rome, and St. Petersburg, the delegates were received respectively by Count Beust, Visconti Venosta, and General Timatieff; and then introduced to M. Brunner de Wattenwyl, Signor D'Amico, and General de Luders, the heads of the several telegraph departments, as their chairmen for the work in hand.

We heard with some regret, a short time ago, a rumour that this precedent, so long established that it has grown into a rule which the delegates would naturally expect to see observed on the present occasion, would possibly be departed from, by the retention and appointment on the part of the Post Office of a foreign official, not a delegate, to act as chairman. There can be little doubt that, following the spirit of their previous practice, the delegates, being in England, would prefer to be placed under an Englishman. We trust, therefore, that if the rumour had any foundation in fact, the intention has been abandoned. To send abroad for a chairman for meetings to be held in England would certainly seem to border somewhat on the absurd. It would, perhaps, be invidious to mention names, but in the Post Office itself, and in the large telegraph departments of the Indian Government, it is perfectly well known that there are able officers of high position, and in one instance, at least, of considerable actual experience in international conferences, whose eminent qualifications for the post of honour are undeniable.

Except for this rumour, all the arrangements appear to be well considered, and we learn with satisfaction that the Post Office, the Indo-European

Government Telegraph Department, the English Telegraph Companies, and the Society of Telegraph Engineers are arranging to do all they can to welcome the delegates who have come to us literally from all parts of the world, and to make their stay amongst us as agreeable as possible.

Lieut.-Col. Bateman-Champain, R.E., will be a delegate for the Indian Government at the International Conference.

Major Webber, R.E., goes to the Cape on the Staff of Sir Garnet Wolseley.

MUIRHEAD'S DUPLEX SYSTEM.

By A. MUIRHEAD.

(*Continued from page* 162.)

THE artificial line or "inductive resistance" may also be formed on a plan patented by Mr. Herbert A. Taylor, and the writer in 1875, whereby the conducting strip of tinfoil in the apparatus described is replaced by a conducting leaf of plumbago paper, that is a paper made by mixing about 50 per cent. of powdered plumbago with the paper pulp, in the same way as other powders are sometimes introduced for the purpose of giving substance to paper. The order of plates in the make-up of these plumbago inductive resistances, then becomes (1), plumbago paper for the conducting part of the circuit; (2), paraffined paper for the insulator; and (3), tinfoil for the earth or inducing plates. The plumbago plates are connected in series, and the earth plates to earth, in the same way as is shewn in fig. 2. Practically, however, the contacts between these plumbago resistances are somewhat difficult to make, and the tinfoil conducting strip has been preferred.

Inductive resistances, made by first saturating silk or cotton-covered copper or other wires in melted paraffin, and then winding spirally with an external coating of gilded copper strip, such as is used in working gold lace for uniforms, has also been patented by Mr. John Muirhead, and the writer in 1875. This material is chiefly intended for use as an artificial line for duplex working on land lines; and it has been successfully applied to the duplexing of the London to Emden (Germany) line, consisting of a short cable and about 250 miles of land line. The cable part is represented in the artificial line by sections of Muirhead's artificial cable, and the land line portions by bobbins of this fine metal-coated wire. The differential method is here employed, the Morse receiver being operated through the medium of a highly sensitive relay.

In establishing the duplex balance it is found necessary to resort to certain adjusting devices in order to approximate the first part of the artificial line to the varying conditions of the first few knots of the cable. Of course, theoretically, an artificial cable made on the principle involved in the resistances is alone sufficient to establish the duplex balance in conjunction with the Wheatstone bridge or differential arrangement of apparatus; but this implies the condition that the artificial cable is exactly equivalent to the actual one, in every respect, a condition which is obviously unattainable in practice, seeing that most cables are laid in varying depths of water at various temperatures. Nevertheless, it always remains true that the nearer the artificial approximates, electrically speaking, throughout its entire length to the real cable, the less need there is for auxiliary adjustments. The writer has found, from many experiments, that some of these adjustments have considerable power, and are able to correct for a slight difference of type between the artificial line and the real one, as well as to allow of the former being curtailed by a certain number of knots, thus reducing the cost of the apparatus. Particular adjustments are also found to have particular corrective influences on the balance, and a mutual sympathy, so that the alteration of one affects another in a particular fashion. To enable the reader to understand the nature of these adjustments, I have sketched some of the most important of these in fig. 3, which represents the arrangement of apparatus for duplex working after the Wheatstone Bridge method (see fig. 1), the method which we have applied to all the cables we have duplexed.

In the diagram r_1, r_2, r_3, r_4, and r_5, Fig 3 are adjustible resistances; s is the receiving condenser, generally from 20 to 60 microfarads according to the length of the cable; s_1 is an adjustable condenser applied to the end of the receiving circuit to which the cable is attached. The other apparatus explains itself.

In order to render this paper as complete and instructive as possible, I will now give an example or two of the actual working balances established on cables by Muirhead's system; beginning with the Marseilles to Malta cable which, besides being the first long cable, is the simplest example of the balance yet obtained. At Marseilles the balance for this cable (which is 826 knots long, and crosses the Mediterranean to Bona before proceeding to Malta) consists simply of the Wheatstone balance, and Muirhead's artificial cable, having some of the final inductive plates dispensed with, and the conductor of the artificial line to earth through a resistance of 7000 units.

The Aden to Bombay cable of 1817 knots, is balanced at Aden by making $s_1 = 1{\cdot}23$ mf.; $r = 0$; $r_3 = 0$; $r_2 = 210{,}000$, at a point 250 miles down the artificial line; $r_4 =$ infinity; and $r_5 =$ infinity. The proportion of artificial to the actual line is about three to four; and the resistances in the sides of the bridge are 2000 and 2030 respectively. The total resistance of this line is 11,827 ohms, and the capacity is 656 microfarads. These two cables are worked by the Siphon Recorder, which, although an extremely sensitive instrument is really more easy to effect a duplex balance with than the mirror galvanometer. As is well known, the rapid succession of signal currents in a cable gives rise to a long slow undulation or wave of electricity in a cable, on which the individual signals ride as a series of ripples. The recorder coil is not nearly so sensitive to this slow wave as the mirror or the galvanometer, and the recorder zero is shifted less markedly than that of the mirror. In mirror reading the movement of the zero is very apt to confound itself with the signals themselves, because the light spot moves always in one straight line up and down the scale, whereas in recording, the

FIG.4.

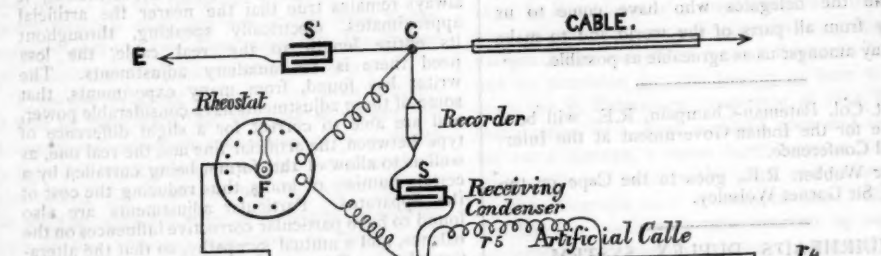
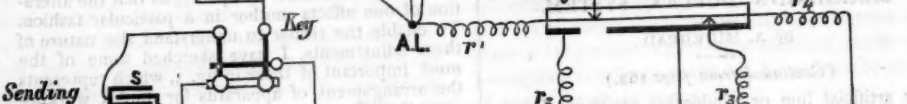


FIG.5.



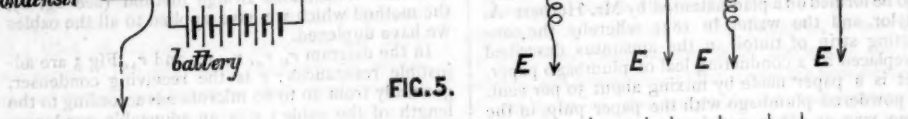


FIG. 6.

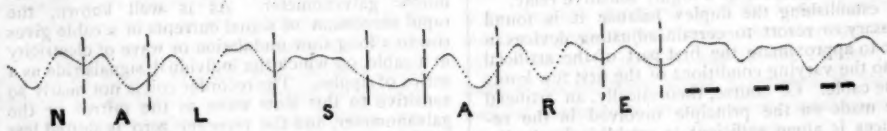


FIG. 6A.

displacement of the zero is transverse to the direction of the signals along the paper "slip." And further, on the mirror the signals are fleeting and present themselves to the eye for a moment only, whereas by the recorder the signals are permanently written and can be deciphered at leisure. For these reasons the duplex balance with the mirror galvanometer requires to be more perfect and requires a larger amount of artificial line than in the case of the recorder.

The longest cable yet duplexed by our system, is the Direct United States Atlantic cable from Ballinskelligs Bay in Ireland, to Torbay in Nova Scotia, a length of about 2,423 knots, and on this cable, the mirror galvanometer is the receiving instrument employed. It is the first Atlantic cable to which the duplex system of working was applied. The total resistance of this cable is 7,315 Siemens' units, and the total capacity 987·6 microfarads. At Ballinskelligs, the balance is effected by making $r_1 = 22$, $r_2 = 1{,}400$ S.U., $r_3 = 10{,}000$, $r_4 = 1{,}600$, S.U., $r_5 =$ infinity, $s_1 = 0{\cdot}06$ mf., $s = 60$ mf., the cable branch of the Wheatstone balance being = 2,000 ohms, and the artificial line side = 2,036 ohms.

At Torbay, the balance is got by making $r_1 = ,0$ $r_2 =$ S.50., $r_3 = 5{,}000$ at 1,600 knots down the line, $r_4 =$ infinity, $r_5 = 90{,}000$, $s_1 = 4{\cdot}37$ mf., $s = 60$ mf.; the cable branch of the Wheatstone balance being 2,000, while the artificial line side is 2,010.

With these adjustments, the proportion of capacity in the artificial line, to that of the actual cable, is as 4 to 5. The speed of signalling obtained on the Direct United States cable when working duplex, is 100 letters per minute each way, making a total of 45 letter words per minute. Experience, indeed, proves that the duplex system of working submarine cables practically doubles their carrying capacity; since the time formerly lost in switching over from "send" to "receive," and back again from "receive" to "send," is all saved. On the other hand, duplex reading on the mirror is very fatiguing work to the clerk, for his eyes require to follow the spot incessantly, whereas, in "simplex" working, he can get a relief from reading in the act of sending a message.

The following woodcuts are fac-similes of the signals received at Aden and Bombay respectively on the duplex system, through the new Aden-Bombay cable, at the rate of eighteen words per minute, the ordinary speed of working of that cable.

Muirhead's duplex system was, as I have before mentioned, first experimentally tried on the Marseilles-Bona cable, in July, 1875. In February, 1876, it was adapted to the Marseilles-Malta cable; in April, of the same year it was applied to the Suez-Aden, or Red Sea cable, and in January of the following year to the Aden-Bombay cable. All these cables belong to the Eastern Telegraph Company, and it is the duty as well as the pleasure of the writer to state here that the early success attending the application of duplex to cables is largely attributable to the encouragement so freely given by the managing director of the Company, Sir James Anderson, who, as a reward, has secured to his Company the benefit of having their cables worked on the duplex method several years before any other company.

THE INDUCTION BALANCE AND SONOMETER.

By PROF. D. E. HUGHES.*

IMMEDIATELY upon the announcement of Arago's discovery of the influence of rotating plates of metal upon a magnetic needle (1824), and Faraday's important discovery of voltaic and magneto-induction (1831), it became evident that the induced currents, circulating in a metallic mass, might be so acted upon either by voltaic or induced currents as to bring some new light to bear on the molecular construction of metallic bodies.

The question was particularly studied by Babbage, Sir John Herschel, and by M. Dové † who constructed an induction balance, wherein two separate induction coils, each having its primary and secondary coils, were joined together in such a manner that the induced current in one coil was made to neutralise the induced current in the opposite coil, thus forming an induction balance, to which he gave the name of differential inductor. In those days physicists did not possess the exquisitely sensitive galvanometers and other means of research that we possess to-day, but sufficiently important results were obtained to prove that a vast field of research would be opened if a perfect induction balance could be found, together with a means of correctly estimating the results obtained. In experimenting with the microphone I had ample occasion to appreciate the exquisite sensitiveness of the telephone to minute induced currents. This led me to study the question of induction by aid of the telephone and microphone. The results of those researches have been already published.‡

Continuing this line of inquiry, I thought I might again attempt to investigate the molecular construction of metals and alloys, and with this object I have obtained, after numerous comparative failures, a perfect induction balance, which is not only exquisitely sensitive and exact, but allows us to obtain direct comparative measures of the force or disturbances produced by the introduction of any metal or conductor.

The instrument which I have the honour to present to the Royal Society this evening, consists, 1st, of new induction currents balance; 2nd, microphone, with a clock as a source of sound; 3rd, electric sonometer, or absolute sound measurer, a late invention of my own; 4th, a receiving telephone and three elements of Daniells' battery.

[Fig. 1 represents the induction balance and sonometer with its auxiliary apparatus as shown at the society, S^2 being the balance; S^1 the sonometer; M the microphone, and clock C; B, the battery; G, a galvanoscope; and T, the telephone: t_1 and t_2 are terminals. Figs. 2 and 3 give the same arrangement in theory.]

In order to have a perfect induction currents balance suitable for physical research, all its coils as well as the size and amount of wire, should be equal. The primary, c, c_1, and secondary coils,

* Paper read before the Royal Society, May 15th.

† De la Rive, "Treatise on Electricity," vol. i, chap. v. London, 1853.

‡ "Comptes Rendus," December 30, 1878, and January 20, 1879; Society of Telegraph Engineers, March 15, 1879.

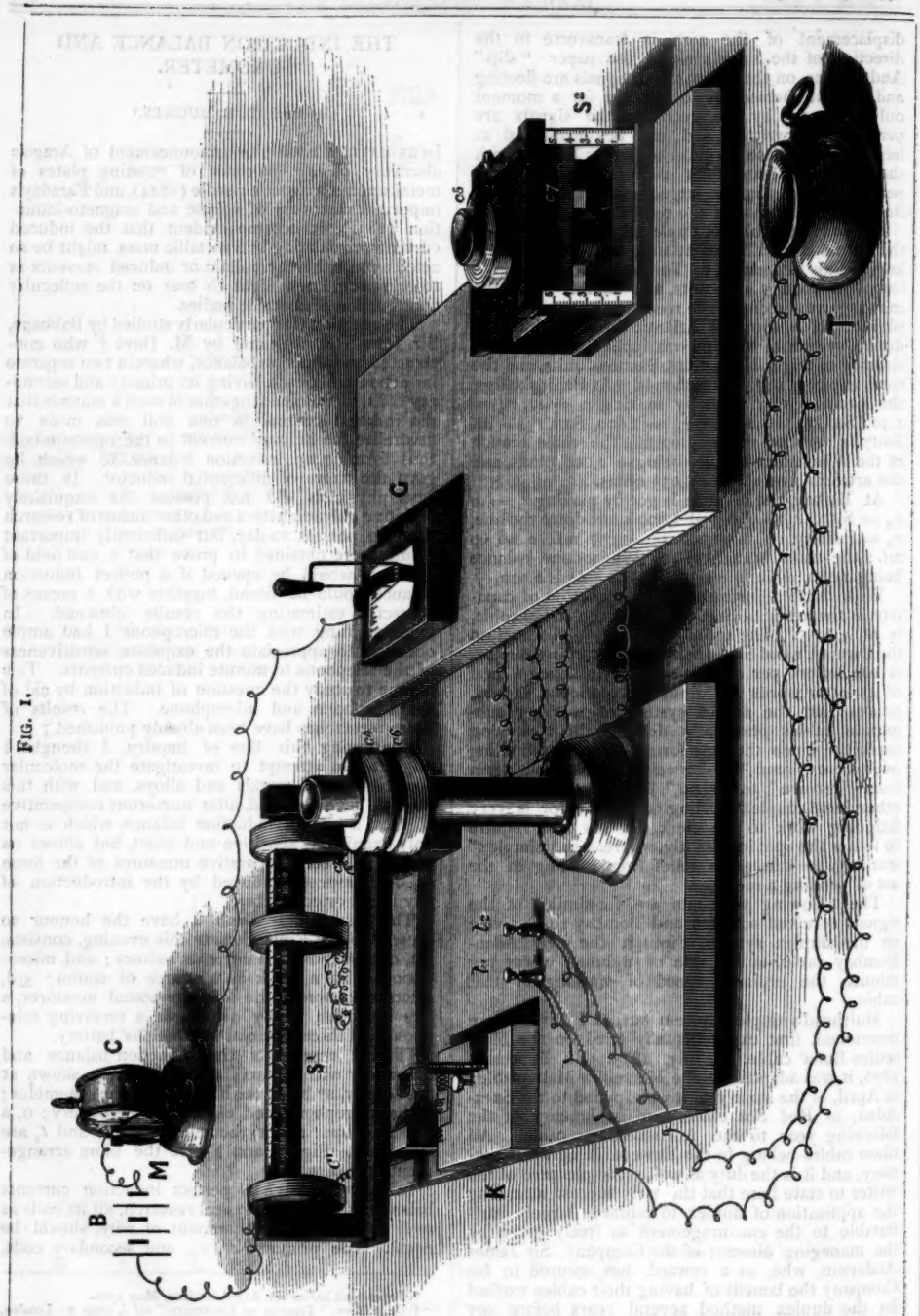


FIG. 1.

c_3, c_5, should be separate and not superposed. The exterior diameter of the coils presented this evening is 5½ centims., having an interior vacant circular space of 3½ centims., the depth of this flat coil or spool is 7 millims.

Upon this box-wood spool are wound 100 metres of No 32 silk-covered copper wire. I use four of such coils, formed into two pairs, the secondary coil, c_4 or c_5, being fixed permanently, or by means of an adjustable slide, at a distance of 5 millims. from its primary c_6 or c_7; on the second similar pair there is a fine micrometer screw, allowing me to adjust the balance to the degree of perfection required.

These two pairs of coils should be placed at a distance not less than 1 metre from each other, so that no disturbing cause should exist from their proximity.

The two primary coils are joined in series to the battery, the circuit also passing through the microphone.

In place of the telephone I have sometimes used a magnetic pendulum, the swing or the arc described indicating and measuring the forces. * I am at present engaged upon a very sensitive voltameter which shall indicate and measure the force of rapid induced currents. The telephone, however, is well adapted as an indicator, but not as a measurer of the forces brought into action. For this reason I have joined to this instrument an instrument to which I have given the name of electric sonometer s^1, fig. 1. This consists of three coils, c_1, c_4, c_2, fig. 3, similar to those already described, two of which c_1, c_2, are placed horizontally at a fixed distance of 40 centims. apart, and the communication with the battery is so arranged that there are similar but opposing poles in each coil; between these there is a coil, c_3, which can be moved on a marked sliding scale divided into millimetres; in a line with these two opposing primary coils, the centre coil is the secondary one, and connected by means of a circuit changing key K, with the telephone T, in place of the induction balance. If this secondary coil is near either primary coil, we hear loud tones, due to its proximity. The same effect takes place if the secondary coil is near the opposing coil, except that the induced current is now in a contrary direction, as a similar pole of the primary acts now on the opposite side of the induction coil; the consequence is, that as we withdraw it from one coil approaching the other, we must pass a line of absolute zero, where no current whatever can be induced, owing to the absolute equal forces acting equally on both sides of the induction coil. This point is in the exact centre between the two coils, no matter how near or distant they may be. We thus possess a sonometer having an absolute zero of sound; each degree that it is moved is accompanied by its relative degree of increase; and this measure may be expressed in the degrees of the millimetres passed through, or by the square of the distances in accordance with the curve of electro-magnetic action.

If we place in the coils of the induction balance, or s_1, a piece of metal, say copper, bismuth, or iron, we at once produce a disturbance of the balance, and it will give out sounds more or less intense on the telephone according to the mass, or if of similar sizes, according to the molecular structure of the metal. The volume and intensity of sound is invariably the same for a similar metal. If by means of the switching key K the telephone is instantly transferred to the sonometer, and if its coil be at zero, we should hear sounds when the key is up or in connection with the induction balance, and no sounds or silence when the key is down or in connection with the sonometer. If the sonometer coil was moved through several degrees, or through more than the required amount, we should find that the sounds increase when the key is depressed; but when the coil is moved to a degree where there is absolute equality, if key is up or down, then the degree on scale should give the true value of the disturbance produced in the induction balance; and this is so exact that if we put, say a silver coin whose value is 115°, no other degree will produce equality. Once knowing, therefore, the value of any metal or alloy, it is not necessary to know in advance what the metal is, for if its equality is 115°, it is silver coin; if 52, iron; if 40, lead; if 10, bismuth; and as there is a very wide limit between each metal, the reading of the value of each is very rapid, a few seconds sufficing to give the exact sound value of any metal or alloy.

During the course of these experiments with this instrument I noticed that my own hearing powers varied very much with state of health, weather, &c., that different individuals had wide differences of hearing, and that nearly in all cases one ear was more sensitive than the other; thus whilst my degree of hearing was 10°, another might be 60° in one ear and 15° in the other.*

Dr. Richardson, F.R.S., who upon my invitation investigated this subject, became so impressed with the value of the instrument as an absolute measure of our hearing powers, and its capabilities of throwing much light upon its relation with health, that he has undertaken a series of researches which will extend over some time, and which I think from some facts already gained will be of great value to the medical profession. These experiments are now in his very able hands, and he will in due time announce the results to the Royal Society.

If an observer's hearing is limited to 10°, how can we hear results below this line? I should have stated that when used to measure the hearing power, we determine on a constant standard of force such as one element Daniell, but if we increase the number of elements we in the same ratio increase the inductive disturbance, and thus by a large increase of force bring within our range results too feeble to be heard without its aid, the sonometer constantly, however, giving the same degree for equality as the increased force is also used on this instrument. Thus in our measurements we can entirely neglect the amount of battery, as its comparative results remain a constant.

As a rule three Daniell elements will be found quite sufficient, and even this weak force is so exquisitely sensitive that it will find out the smallest fraction of difference in weight or structure

* "Telegraphic Journal," December 15, 1878.

* To this portion of my instrument when used as a measurer of our hearing powers, we have given the name of audiometer.

of metals. Thus two silver coins such as a shilling, both quite new, and both apparently of the same weight, will be found to possess a difference of weight which the instrument at once indicates.

The following experiments will show its exceeding sensitiveness and its wide field of usefulness as an instrument of research.

I. If we introduce into one pair of the induction coils any conducting body, such as silver, copper, iron, &c., there are set up in these bodies electric currents which react both upon the primary and secondary coils, producing extra currents whose force will be proportional to the mass, and to its specific conducting powers. A milligramme of copper on a fine iron wire, finer than the human hair, can be loudly heard and appreciated by direct measurement, and its exact value ascertained. We can thus weigh to an almost infinitesimal degree the mass of the metal under examination; for instance, if we take two English shilling pieces fresh from the Mint, and if they are absolutely identical in form, weight, and material, they will be completely balanced by placing one each in the two

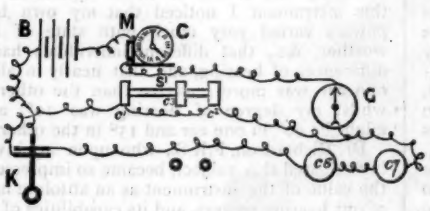


FIG. 2. PRIMARY CIRCUIT.

separate coils, provided that or these experiments there is an adjustable resting place in each pair of coils, so that each coin may lie exactly in the centre of the vacant space between the primary and secondary coils. If, however, these shillings are in the slightest degree worn, or have a different temperature, we at once perceive this difference, and if desired, measure it by the sonometer, or, by lifting the supposed heaviest coin at a slight distance from the fixed centre line, the amount of degrees that the heaviest coin is withdrawn will show its relative mass or weight as compared with the lightest. I have thus been able to appreciate the difference caused by simply rubbing the shilling between the fingers, or the difference of temperature by simply breathing near the coils, and in order to reduce this sensibility within reasonable limits, I have only used in the following experiments 100 metres of copper wire to each coil and 3 cells of battery.

II. The comparative disturbing value of discs of different metals, all of the same size and form as an English shilling, and measured in millimetre degrees, by the sonometer, is the following :—

Silver (chemically pure)	125	Iron (chemically pure)	45
Gold " "	117	Copper (antimony alloy)	40
Silver (coin)	115	Lead	38
Aluminium	112	Antimony	35
Copper	100	Mercury	30
Zinc	80	Sulphur (iron alloy)	20
Bronze	76	Bismuth	10
Tin	74	Zinc (antimony alloy)	6
Iron (ordinary)	52	Spongy gold (pure)	3
German silver	50	Carbon (gas)	2

These numbers do not agree entirely with any list of electrical conductivity I have yet met with; the numbers are, however, invariably given by the sonometer, and the divergence may be due to some peculiarity of structure of the metals when formed into discs. Future investigations with this instrument will, no doubt, give more correct values than I have been able to obtain with my limited means of research.

III. It will be seen from the above, that the

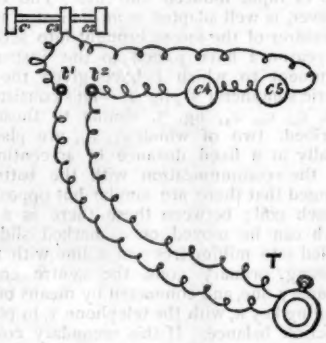


FIG. 3. SECONDARY CIRCUIT.

instrument gives very different values for different metals or alloys, consequently, we cannot obtain a balance by employing two discs of different metals, and the instrument is so sensitive to any variation in mass or matter, that it instantly detects the difference by clear loud tones on the telephone. If I place two gold sovereigns of equal weight and value, one in each coil, there is complete silence, indicating identity, or equality between them; but if one of them is a false sovereign, or even gold of a different alloy, the fact is instantly detected by the electrical balance being disturbed. The instrument thus becomes a rapid and perfect coin detector, and can assay any alloy, giving instantly its electrical value. The exceeding sensitiveness of this electrical test I shall demonstrate by experiment.

Again, as regards coins, it resolves an almost magical problem. Thus, if a person puts one or several coins into one pair of coils, the amount or nominal value being unknown to myself, I have only to introduce into the opposite coils, different coins

successively, as I should weights in a scale, and when perfect balance is announced by the silence, the amount in one box will not only be the same nominal value but of the same kind of coin.

IV. We find by direct experiment with this instrument, that the preceding results are due to electric currents, induced by the primary coil, and that it is by the reaction of these that the balance is destroyed, for, if we take an insulated spiral disc or helix of copper wire, with its terminal wires open, there is no disturbance of the balance whatever, notwithstanding that we have introduced a comparatively large amount of copper wire; but on closing the circuit, the balance is at once very powerfully disturbed.

If the spiral is a flat one, resembling a disc of metal, and circuit closed, we find that loud tones result when the spiral is placed flat, or when its wire is parallel to those on coils; but if it is held at right angles to these wires, no sound whatever is heard, and the balance remains perfect. The same thing occurs with discs of all non-magnetic metals, and a disc of metal placed perpendicular to the coils exerts no influence whatever. The contrary result takes place with a spiral of iron wire or disc of iron, the induced current circulating in the spiral is at its maximum when the spiral lies flat or parallel with the coils, giving no induced current whatever when at right angles; but the disturbances of the induction balance are more than fourfold when perpendicular to the wires of the coils than when parallel with the same. That this result is simply due to the property of magnetic bodies of conduction of magnetism, we shall see in some following experiments.

That the currents in non-magnetic metals travel in a circle corresponding to that of the primary coil, may be seen with spongy gold. In its first extremely divided state it falls below our zero of hearing; on slightly shaking the bottle we have 2° as its value; on pressing it its value rapidly increases with the pressure, until, when formed into a solid disc, its value becomes 117°.

V. The instrument proves that a very remarkable difference exists in bars of iron of the same exact form and size, but of different provenance or treated in a different manner; in point of fact, no two bars, cut off the same rod, and treated alike, are exactly of the same value, or induce a complete balance.

Mr. Stroh, the eminent instrument maker, has kindly furnished me with numerous samples, varying in value in degrees of the sonometer from 100 to 160.

Chemically pure iron was found to be the best, but still very slightly superior to ordinary iron which had been drawn into a wire of the required thickness; the fibrous condition thus developed being highly favourable (if softened by heat) for the conduction of magnetism. From numerous examples I select a few indicative values :—

	Softened.	Tempered.
Chemically pure iron ...	... 160	... 130
Forged soft iron ...	... 150	... 125
Wire-drawn iron ...	... 156	... 120
Cast steel	... 120	... 100

(To be continued.)

NEW ELECTRIC LAMPS AT THE ALBERT HALL.

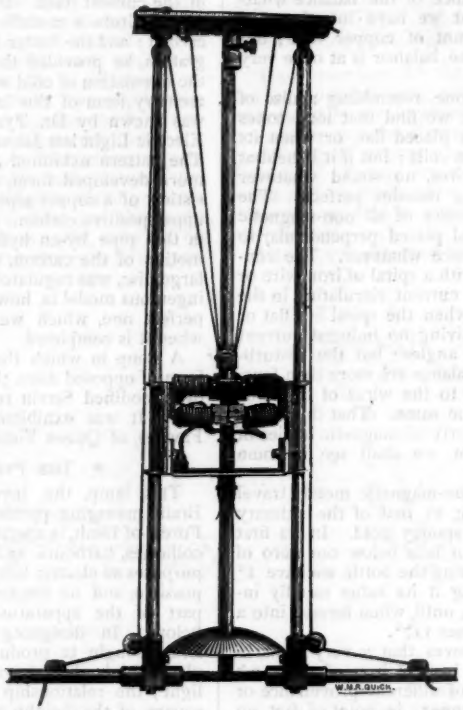
THE most interesting of the novel electric lamps displayed at the Albert Hall during the recent exhibition of Electric Lighting Apparatus was, perhaps, the single carbon lamp of Dr. C. Siemens. Dr. Siemens appears to have been the first to see that the negative carbon wasted away by reason of its incandescent state, and not by the tearing action of the current itself. It, therefore, occurred to him to substitute a metallic electrode for the negative carbon; and the better to preserve it from disintegration, he provided that it should be kept cool by the circulation of cold water in its interior. A rudimentary form of this lamp, it may be remembered, was shewn by Dr. Tyndall, in his lecture on the Electric Light last January, at the Royal Institution. The pattern exhibited at the Albert Hall was a far more developed form, the negative electrode consisting of a copper pipe bent into a peak below the upper positive carbon. Cold water was kept flowing in this pipe by an hydraulic arrangement, and the motion of the carbon, which was of the shape of a large disc, was regulated by wheel-work. Even this ingenious model is, however, only a step to a more perfect one, which we hope to describe in detail when it is completed.

A lamp in which the two carbons were in the form of opposed discs, their motions being regulated by a modified Serrin regulator, also deserves mention. It was exhibited by Messrs. Crompton and Fawkes, of Queen Victoria Street.

THE PYRAMID LAMP.

This lamp, the invention of Mr. W. Blanch Brain, managing partner of the Trafalgar Colliery, Forest of Dean, is specially designed for illuminating collieries, harbours, and large sheds. For colliery purposes an electric lamp requires to be as simple as possible, and no shadow should be thrown by any part of the apparatus on the illuminated field below. In designing his lamp, therefore, Mr. Brain sought to produce one which would, when placed high, shed down a pyramid of unobstructed light; the relationship of the lit surface to the square of the height suggesting the name of the lamp. As will be seen from the accompanying illustration there is no basement to the lamp, the arc being at the lowest point, where the three carbons meet. The arc is formed between the vertical carbon and the point of junction of the two horizontal carbons. For this purpose, the vertical carbon is withdrawn to a limited distance, by the current when it is put on. The contact between the two horizontal electrodes becomes highly incandescent, and both of these carbons are worn down to fine pencil points which glow with a white heat. A curved metal reflector is supported over the arc to throw the light down. The vertical carbon, which is the positive electrode, is lifted up, so as to establish the arc by means of the electro-magnet, seen in the middle of the lamp. This electro-magnet consists of three coils, an upper and two lower. The lower pair are hinged at the outsides, and their inner poles are made of soft iron pieces hollowed out, so as to allow the vertical carbon to pass freely between when the current is off. In this case the vertical carbon drops down

and rests upon the two horizontal ones. When, however, the current is put on the lamp, it traverses all three coils of the electro-magnet, and the two lower or hinged coils being thereby attracted towards the upper one, they clutch the vertical carbon and lift it up with them to the adjusted length of the arc. This length is adjusted by an oblique washer and screw, after the manner employed in the Wallace-Farmer lamp, *see* TELEGRAPHIC JOURNAL for November 1st, 1878.



It will be seen from the figure that the carbons are pulled together by means of cords; but it is noteworthy that the weight which actuates them is the electro-magnetic adjusting apparatus itself. Several advantages are claimed for this lamp: for example, the positive carbon is free to move through the middle of the lamp when no current is on, and hence as long a carbon as is desired may be employed; that shewn in the Albert Hall being one metre. If a contact-breaker be introduced into the circuit, the lamp can be extinguished and re-lighted some hundreds of times per minute without any discernible periods of darkness; a feature which engineers engaged in pile-driving in the bed of a rapid river will duly appreciate. When the length of the arc becomes too great it is reset, as in the Wallace-Farmer lamp, the re-setting recurring at stated intervals of twelve or fifteen minutes, as may be determined by the size of the carbons employed. The economy of the lamp is also in its favour, since it can be sold for £6 10s., and there need be little or no waste of carbon, for even small points can be consumed by inserting them in holders, which take the place of longer rods. The invention was patented December 14, 1878, and it has been successfully introduced into the Trafalgar Works, and on the Bathurst Wharf, Bristol.

(To be continued.)

ORME'S ELECTRIC LAMP.

WITH a view to obviate the use of clockwork in electric lamps and to insure a steady movement of the carbons, Mr. Orme has constructed the regulator illustrated by the figures on the following page.

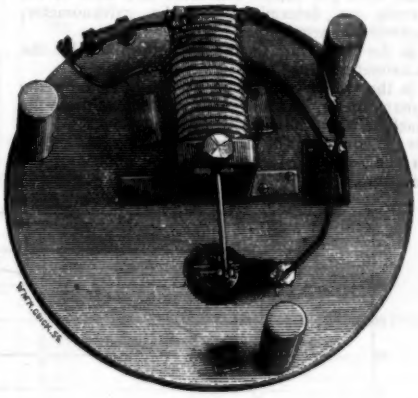
The negative carbon (which should be twice the diameter of the positive) is placed in the upper socket and screwed in tightly. The positive carbon is placed between the two wheels below, which hold it in a line perpendicular with the negative carbon.

Beneath the stand is an electro-magnet, the lower arm of which is movable and capable of being attracted to the upper arm. A connecting rod passes from the lower arm of the magnet, up the tube, which supports the lower carbon, to a ratchet wheel at the side of and on the same axle as the larger wheel, which is thus capable of being revolved by the up and down motion of the lower arm of the magnet. There is a small spring on the left hand side of the ratchet wheel, which prevents this wheel from being carried back by the pressure of the rod as it

rises, and, yet, by the arrangement of a second small spring, allows of a slight backward movement for the purpose of forming the electric arc between the carbons.

The second figure shows the connections beneath the stand.

When the lamp is connected to a battery or other source of electricity, the positive current passes



from the binding screw of the magnet round the magnet, up the tube and positive carbon to the negative carbon, which should touch the lower one, and so back through the upper carbon support and terminal at its foot, to the battery. Immediately the circuit is complete, the lower arm of the magnet is attracted and held tightly to the upper arm, but in its passage it moves the connecting rods,[1] which push back the wheel, and thus separate the carbons to the desired extent of the arc. When the positive carbon is burnt away, so that the circuit is broken, the lower arm of the magnet falls, thus turning the ratchet wheel and bringing the carbons again into contact.

The advantage of this system is that any length of carbon may be employed, a hole being made in the stand so that the positive carbon may pass through; the lamp is always ready for action and is controlled entirely by the current, and as the negative carbon burns away but very slowly compared to the positive, the arc practically remains in one position. Messrs. Jackson and Co., of the Barbican, are the agents for the sale of these lamps.

ON ELECTRIC LIGHTING.

By Dr. JOHN HOPKINSON, F.R.S., M. Inst. M.E.

(*Continued from page* 170.)

PRELIMINARY to experiments on the current, determinations of resistances were made. The resistance of each brass coil was first determined, to afford the means of calculating the value of c in any subsequent experiment. When the ten are coupled in parallel circuit, the calculated resistance was 0·29 ohm, whilst 0.292 was obtained by direct measurement. The leading wire was then examined; the further ends being disconnected, the insulation resistance was found to be over 60,000 ohms; how much over it was immaterial to learn. When the ends of the cable were connected the resistance was found to be 0·129 ohm. The resistances in the machine were found to be as follows when cold: magnet coils 0·156 and 0·152 respectively, armature coil 0·324; total 0·632. Direct examination was made of the whole machine in eight positions of the commutator, giving 0·643 ohm, with a maximum variation from the mean of 0·6 per cent. After running the machine for some time the resistance was found to be 0·683, an increase which would be accounted for by a rise of temperature of 12° C. or thereabouts. The resistance of the calorimeter is 0·20, without its leading wire, which may be taken as 0·01. We have then in circuit three resistances which must be considered: (1) the resistance of the machine and leading wire, assumed throughout as 0·81, denoted by c_1; (2) the resistance of the brass coils c, calculated from the several determinations, with the addition of the resistance of the leading wire 0·02, and denoted by c_2; (3) when present, the resistance of the calorimeter and leading wire denoted by c_3.

Two approximate corrections were employed, and should be detailed. The first is the correction for the considerable heating of the resistance coils c. These were arranged in two sets of five each, five being in parallel circuit, and the two sets in series. The current from the machine, being about 7·4 Webers in each wire, was passed for three or four minutes; the circuit was then broken, and the resistance c_2 was determined within one second of breaking circuit, when it was found to be about 5 per cent. greater than when cold. As the resistance was falling, the following was adopted as a rule of correction: square the current in a single

wire, and increase the resistance c_2 by $\frac{1}{10}$th per cent. for every unit in the square. The second correction is due to the fact that the calorimeter was losing heat all the time it was being used. It was assumed that it loses 0·01° C. per minute for every 1° C. by which the temperature of the calorimeter exceeds that of the air; this correction is of course based on the experiment already mentioned.

The method of calculation may now be explained:—

R is the total resistance of the circuit, equal to $c_1 + c_2 + c_3$;

is the current passing in Webers;

the electromotive force round the circuit in Volts;

W_1 the work per second converted into heat in the circuit, as determined by the galvanometer, measured in ergtens per second;

W_2 is the work per second as determined by the calorimeter;

W_3 is the work per second as determined by the dynamometer, less the power required to drive the machine when the circuit is open;

HP is the equivalent of W_3 in horse-power;

n is the number of revolutions per minute of the armature.

flowing, or the values of Q in the table, and the ordinates the electromotive forces, or the values of E reduced to a speed of 720 revolutions per minute. The curve may also be taken to represent the intensity of the magnetic field. It will be remarked that there is a point of inflection in the curve near the origin. The experiments 1 to 5 indicate that this is the true form of the curve, and it is confirmed in a remarkable manner by a special experiment. A resistance intermediate between 5½ and 4 was used in circuit, and E and Q were determined in two different ways: first, by starting with an open circuit, which was then closed; secondly, by starting with a portion of the resistance short-circuited, and a very powerful current passing, and then breaking the short circuit. It was found that E and Q were four times as great in the latter case as in the former. Unfortunately the numbers are not sufficiently accurate to be given, as the solutions of the standard battery had become mixed.

The curve really gives a great deal more information than appears at first sight. It will determine what current will flow at any given speed of rotation of the machine, and under any conditions of the circuit, whether of resistances or of opposed electromotive

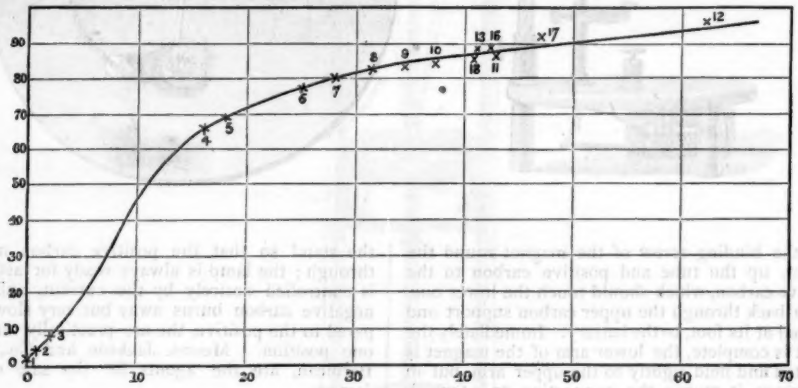


FIG. 4.

Then:

$$Q = \frac{9}{8} \times \frac{a+b}{b} \times \frac{1}{c_2},$$

$$E = QR,$$

$$W_1 = EQ,$$

also $W_2 = \frac{R}{0{\cdot}2}$ multiplied by the mechanical equivalent of the heat generated per second in the calorimeter.

The accompanying table gives the results of the experiments. A power 0·21 ergtens, or 0·28 horse-power, was required to drive the machine at 720 revolutions on open circuit. An examination of the table shows that the efficiency of the machine is about 90 per cent., exclusive of friction. Comparing experiments 11 and 13, and also the last four experiments, it is seen that the electromotive force is proportional to the speed of rotation within the errors of observation. Experiments 14, 15, and 16 were intended to ascertain the effect of displacing the commutator brushes.

The principal object of the experiments was to ascertain how the electromotive force depended on the current. This relation is represented by the curve of fig. 4, in which the abscissæ represent the currents

forces. It will also give very approximate indications of the corresponding curve for other machines of the same configuration, but in which the number of times the wire passes round the electromagnet or the armature is different.

It will be well to compare these results with those obtained by others. M. Mascart worked on a Gramme machine with comparatively low currents: he represents his results approximately by the formula

$$E = n(a + bQ),$$

where a and b are constants. This corresponds to the rapidly rising part of the curve of Fig. 4. Mr. Trowbridge with a Siemens machine obtained a maximum efficiency of 76 per cent., and states the machine was running below its normal velocity. Mr. Schwendler's results when fully published, will probably be found to be the most complete and most accurate existing. In the *précis* he states that the loss of power with a Siemens machine in producing currents of over 20 Webers is 12 per cent. Now taking the author's experiments 4 to 19, the mean value of W_1 is 3·027 and of W_3 3·304: adding to the latter 0·21, the power required to drive the machine when no current passes, it appears that 13·8 per cent. of the power applied is wasted. Again, taking experiments 4, 6, 8, 10 and 12, the mean value

of W_2 is 2·888 and of W_3 3·076, indicating a waste of power amounting to 12 per cent. Of this, as already stated, 0·28 horse-power is accounted for by friction of the journals and commutator brush; the remainder is expended in local currents, or by loss of kinetic energy of current when sparks occur at the commutator.

The author has not yet tried any quantitative experiments with the electric light, but hopes shortly to do so. In the meantime he would remark that, as the lamp is usually adjusted, only half the energy of the current appears in the arc, or 44 per cent. of the energy transmitted to the machine by the strap.

In conclusion the author would express the obligation he is under to Messrs. Chance Brothers and Co. on account of the facilities he has enjoyed for making these experiments at their works. It may be mentioned that one principal object of the research of which this is a beginning is to obtain a minute knowledge of the electric light, with a view to lighthouse illumination.

TABLE I.

No. of Experiment.	R	Q	E	W_1	W_2	W_3	H.-P.	n	Position of Commutator Brush.
1.	1025	0·0027	2·72	.....	.....	.....	.....	720	Original position, as supplied from maker.
2.	8·3	0·48	3·95	0·0019	.....	.....	.....	"	
3.	5·33	1·45	7·73	0·0112	.....	0·042	0·056	"	
4.	4·07	16·8	68·4	1·149	1·140	1·179	1·59	"	
5.	3·88	18·2	70·6	1·285	.....	1·263	1·68	"	
6.	3·205	24·8	79·5	1·972	2·158	2·106	2·81	"	
7.	3·025	26·8	81·1	2·174	.....	2·392	3·19	"	
8.	2·62	32·2	84·4	2·718	2·888	2·780	3·71	"	
9.	2·43	34·5	83·8	2·894	.....	3·370	4·49	"	
10.	2·28	37·1	84·6	3·138	2·903	3·538	4·72	"	
11.	2·08	42·0	87·4	3·671	.....	3·960	5·28	"	
12.	1·345	64·0	86·1	5·510	5·349	5·777	7·70	654	(Strap slipping.)
13.	2·08	41·1	85·5	3·514	.....	3·790	5·05	698	
14.	2·07	36·0	74·5	2·682	.....	2·852	3·80	696	13° extra lead of brush.
15.	2·09	42·7	89·2	3·809	.....	4·233	5·64	708	8° less lead of brush than in original position.
16.	2·09	41·7	87·2	3·636	.....	4·135	5·51	713	5°
17.	2·10	45·0	94·5	4·252	.....	4·810	6·41	759	5°
18.	2·08	40·8	84·9	3·464	.....	4·010	5·35	696	5°
19.	2·06	35·1	72·3	2·538	.....	2·672	3·56	586	5°

Correspondence.

[We do not hold ourselves responsible for the opinions of our correspondents.]

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—With reference to your leading article on "The New Theory of Terrestrial Magnetism," of Professors Ayrton and Perry, in the number of your Journal for May 1st, allow me to call attention to the views which I have published in a memoir on "The Polar Auroras," presented to the *Academie des Sciences*, and dated March 13th, 1876.

After having endeavoured to prove that the aurora was due to a flow of positive electricity directed towards the void of planetary space and not towards thesun, across the mists and frost clouds of the polar regions, I added:—

"Whatever may be the origin of this polar electricity, it must be admitted that it comes from the equator and the tropical regions. But it might be objected that the electrified clouds would become discharged during their progress, and in effect we know that storms become more and more rare as we approach the poles. My former experiments, and others still unpublished,* having led me to suppose that the celestial bodies are charged positively, the only kind of electricity, perhaps, which exists, I should be induced to regard *the earth itself as charged with positive electricity* which develops itself from the sun and seas by a process of simple emission, and spreading over the whole of its surface at the poles as at the equator, produces in the atmosphere very different effects in consequence of the completely opposite meteorological conditions of these regions." (*Comptes Rendus*, vol. lxxxii. p. 626, March, 1876. *Philosophical Magazine*, June, 1876.)

In my complete memoir on the polar aurora, of which the *Comptes Rendus* has only given an extract, but the manuscript of which, in the archives of the *Academie*, presented and dated 13th March, 1876, can be consulted, and of which I have reproduced the chief points in my work, *Recherches sur l'Electricite** (pages 236 and 241), the following passage occurs:—

"The positive electricity thus emanating from the terrestrial globe would not be, according to us, the result of a production or generation properly so called, produced by physical or chemical causes. *It would not be due to evaporation, nor to friction, nor to thermo-electric actions, but would proceed from an original charge or store of electricity, proper to the earth itself*, transported by it, since the time of its formation, and which tended to dissipate itself, like the heat which it possesses, with extreme slowness, by reason of its considerable mass.

"This electricity, penetrating the atmosphere, would extend to the higher and more rarified strata of the air, which offer immense conducting spaces, and would spread itself over the planetary regions. The lower strata of air near the earth not being rari-

* These experiments were published a short time after in a note which I have presented to the *Academie*, dated the 10th April, 1876, and in which I considered equally the sun as having a charge or store of electricity. This note concludes as follows:—

"Thus the sun does not create the electricity which it possesses, any more than the heat and the light which are the transformation of it; *it is a store* which it has received from the nebulous ring of which it is only a particular brilliant, destined to disappear some day. This nebulous ring proceeds from another electric wave, and so on, up to the first cause, the creator of all force and of every movement. Regarded from this point of view, the incandescence of the solar globe, prolonged during a long series of ages, is itself only a spark of short duration in the infinity of time and space." (*Comptes Rendus*, vol. lxxxii. p. 816, April, 1876.)

* Paris: Fournesu, 18, Rue de la Sorbonne, 1879.

fied, we can understand that the positive electricity will be present only in minute quantities, and accumulated in the higher layers. Thus the increase of the quantity of positive electricity in proportion to the elevation of the locality can be explained.

* * * *

"The considerations which consequently arise, agree besides, up to a certain point with the hypothesis of Ampère, admitting the existence of an electric current in a determined direction, enveloping the globe and producing its magnetic action.

"It may be added, in order to explain the emission of the electricity in the atmosphere and, consequently, in space, that this should be a current of very high tension, not merely maintained in a certain thickness of the earth's crust as in a conductor of a limited thickness, but spreading around the whole of the mass of the globe, *by reason of its high tension*."

Having already had occasion to appreciate the spirit of impartiality which exists in the editing of your journal (for you have spontaneously drawn attention in a preceding volume of your journal to the fact that I had first described under the name *d'eclairs en chapelet* a remarkable form of lightning of which some examples have been observed in England), I have ventured to hope that you would allow me to make in your columns the remarks which I have the honour to address to you.

Accept, sir, the assurance, etc.,

GASTON PLANTÉ.

SIR,—It would be a satisfaction to many of your subscribers if you could inform them through the TELEGRAPHIC JOURNAL who has been selected to represent Great Britain at the forthcoming International Telegraph Conference to be held in London in June next. You would remove from the minds of English telegraphers the humiliating thought that they are behind other nations, if so be you can announce that this time our Government has not been obliged to send to Hanover for a man to represent England among the delegates of all nations.

Yours, etc.,

May 14th, 1879. ENQUIRER.

[Your other suggestion has for some time been entertained by us, and may be realised in due time.—ED. T. J.]

THE DUPLEX SYSTEM ON CABLES.

SIR,—I have read in your and other journals accounts of the lecture (which I had also the pleasure of hearing) recently delivered by Mr. Preece on the subject of Duplex Telegraphy before the Society of Arts.

As it appears to me that an incorrect impression is likely to arise from certain statements of the lecturer, I beg to forward you for publication a copy of a letter I have sent to Mr. Preece,

And remain, Sir, yours faithfully,

J. MUIRHEAD, JUNR.

29, Regency Street, Westminster, S.W. *May* 28, 1879.

"DEAR SIR,—I was much surprised to hear you say in your lecture on Monday evening before the Society of Arts that, although I 'had duplexed some of the cables of the Eastern Telegraph Company in the Mediterranean and Red Sea on Mr. Stearns' principle, Mr. Stearns had only recently succeeded in duplexing one of the Anglo-American Company's Atlantic Cables.'

"The inferences naturally drawn from this statement are, first, that in duplexing the Mediterranean and Red Sea cables I had either infringed Mr. Stearns' patents or used them with his consent. Secondly, that I had not duplexed any one of the Atlantic cables, or any of the long cables east of the Red Sea.

"Now it is within your knowledge that I absolutely deny using any of Mr. Stearns' patents, and that for years past I have challenged that gentleman to take legal steps to decide and enforce his claims, but he has not thought fit to accept the challenge, or take any action in the matter.

"It is, I think, also known to you that besides duplexing several cables of the Eastern Telegraph Company in the Mediterranean and in the Red Sea, I have successfully duplexed the following long submarine cables:—

"Suez to Aden	1,500 miles	in 1876.
"Aden to Bombay ...	1,800 "	" 1877.
"The Direct United States Cable, being the longest cable in existence	2,400 "	" 1878.
"Madras to Penang ...	1,300 "	" 1878.

"&c.

"Altogether my system has been applied and was in use upon upwards of 10,000 miles of cable before Mr. Stearns had succeeded in his long protracted efforts to establish duplex on an Atlantic or other long line.

"The method I adopt is distinctly described in my patents and has frequently been fully explained in the scientific and other journals, whereas, we are not yet informed of the means Mr. Stearns has recently employed to duplex one of the Atlantic cables; and it will be obvious to any disinterested electrician, who compares my specifications with those of Mr. Stearns, that I use no part of his inventions, as specified in his patents, but an apparatus, the novelty of which is not, and cannot be, disputed.

"You stated also in your lecture that Mr. Stearns had succeeded in obtaining twenty-five words per minute on the Anglo-American cable (1,800 miles). If you will be good enough to refer to the TELEGRAPHIC JOURNAL of May 15th, 1878, you will find it recorded that upon the Direct United States Cable (six hundred miles longer than the Anglo-American) I obtained a speed of twenty-five words per minute. Now our sending twenty-five words per minute on a cable 2,400 miles long is practically the same thing as sending about forty words per minute on the shorter cable 1,800 miles long.

"I do not ask you to accept my unsupported statement as to the essential difference between mine and Mr. Stearns' system. Sir William Thomson, Mr. Varley, Professor Jenkin, Mr. Latimer Clark, Professor Ayrton and others of the highest authority in the telegraphic world, have given their opinion that my method is quite distinct from what Mr. Stearns claims by his patents.

"Having regard to these well-known facts, I think I have some ground of complaint (as well on my own account as on that of my friends associated with me in the matter) in that you should have omitted to mention in your lecture upon the subject of duplex telegraphy the important work we had accomplished long before Mr. Stearns was able to duplex the only long cable he has ever been successful with, viz., the Anglo-American, and that you should have, in face of the high authorities I have cited to the contrary, stated as a fact that I had used Mr. Stearns' inventions.

"I trust you will do me the justice to read this communication at your next lecture, in order that some of the misapprehensions created on the last occasion may be removed.

"I also request the favour of this letter being published with your lecture in the proceedings of the Society.

"I am, dear Sir, yours faithfully,

"J. MUIRHEAD, JUNR.

"W. H. Preece, Esq.,
"General Post Office, E.C.
"16 *May*, 1879."

Notes.

THE ELECTRIC LIGHT.—Mr. George Livesey, C.E., engineer to the S. Metropolitan Gas Company, in his evidence before the Parliamentary Committee, stated that in his opinion the gas companies should not be allowed to undertake the business of electric lighting as they did not possess the necessary plant, and because it would divert them from their proper business of supplying gas. This objection did not apply to corporations supplying gas. As an engineer he admitted that the electric light was suitable as an illuminating agent, and thought that facilities should be given for its introduction.

MR. FARRAR, of the Board of Trade, said the success of the light for lighthouses was assured, and we should soon have it at all the salient points of the coast. It is already established at the South Foreland, at Sutor Point between Newcastle and Shields, and at the Lizard. The fishermen on the north coast were overwhelmingly in favour of the light; the captain of the Ostend mail boat had complained that it was so dazzling he could not properly see before him. On that account it might be dangerous for vessels to use it at sea. The electric light in a lighthouse would cost rather more than double the outlay upon an oil lamp.

MR. LISTER, engineer in chief to the Mersey Docks and Harbour Board at Liverpool, said in their new dock works, the electric light was better than anything else; and that it would be of greater value to the port at Liverpool on the dockhead in order to allow large vessels to enter harbour by night.

MR. SAMUEL HUNTER, engineer of the Salford Corporation Gas Department, argued against private enterprise being allowed to compete with corporations in electric lighting.

MR. DEACON, borough engineer of Liverpool, referring to Mr. Preece's evidence to the effect that electric lighting conductors could not be laid beside telegraph wires under streets, said that the latter wires were rarely laid on both sides of a street, and that the electric lighting wires could be laid along the unoccupied side.

SIR WILLIAM THOMSON was of opinion that the electric light should be placed as high as possible—say 60 or 80 feet—for outdoor illumination. He anticipated a great future for it and its use in every case where a fixed light is required, whether in large or small rooms, and in lobbies or other places in private houses. He believed also that electricity would be largely used in future as a motive power.

THE ELECTRIC LIGHT AND VISION.—Professor Cohn, of Breslau, finds that letters, spots, and colours, are better perceived through the medium of the electric light than by gas or daylight. The sensation of yellow was increased 60-fold compared to daylight, of red 6-fold, and of green and blue 2-fold. He concludes that the electric light is to be preferred for distant signals to any other.

THE ELECTRIC LIGHT ON THE EMBANKMENT.—A joint report was recently presented to the Metropolitan Board of Works by Sir Joseph Bazalgette, engineer, and Mr. Keates, consulting chemist, with reference to the lighting of the Thames Embankment by electricity. After giving details as to the motive power and other matters relating to the electric machines used, the report entered into a comparison of the cost of electric light as compared with gas. In opal globes the electric light was equal to 155 candles, and in frosted globes to 265 candles. The cost of the electric light was 5·78d. per hour, and to produce a light equivalent in gas would cost in opal globes 2d. per hour, and in frosted globes 3·50d. per hour. In conclusion, the report added:—"There can be no doubt that electric lighting has now established itself as a light which, under particular circumstances of street lighting, or lighting of great interiors, railway stations, or similar places, will be used, but at present there are defects connected with it that must prevent its adoption as a general mode of lighting competing with gas. There is, in our opinion, no prospect at present of any such general competition."

THE illumination of Messrs. Crocker's drapery establishment by Jablochkoff's candles has proved very satisfactory. A 20-light Gramme machine, driven by a Tangye's horizontal high-pressure single cylinder steam engine of 16 horse-power, and 20 burners suspended from various parts of the room, complete the apparatus required. As the premises will not require to be lit electrically during the summer months, everything will be packed and covered until next autumn, when Messrs. Crocker will be ready to use it a moment's notice.

A contract between the Minister of Beaux Arts and the Societe Generale d'Electricite has been signed for lighting the "Salon," or annual Exhibition of Pictures, and also the whole of the Palais de l'Industrie. Two hundred and forty lights will be fitted up in that establishment. This result is due to the success which has attended the lighting up by the Jablochkoff system of the "Ecole des Beaux Arts," which is under the management of the same ministry, and where 24 Jablochkoff candles are burning.

THE Lord Mayor will receive the delegates of the International Telegraph Conference and the members of the International Literary Congress at dinner at the Mansion House on Thursday, June 12. Among the foreign guests expected are M. Victor Hugo, Senor Castelar, Senor Mandes-Léal, M. Jules Simon, M. Ivan Tourgueneff, M. Edmond About, Signor Macchi, Dr. Kalisch, besides a representative number of distinguished English literary men.

THE SPHYGMOPHONE.—While experimenting with the audiometer, it occurred to Dr. B. W. Richardson that he might get a secondary or telephonic sound from the movements of the pulse at the wrist. He effected this in a very simple manner, by adding a microphone to a Pond's sphygmograph. He mounts on a slip of talc a thin plate of platinum and places the talc slip in the sphygmograph as if about to take a tracing of the pulse. He connects one terminal from a Leclanché's cell to the slip of platinum on the talc, and the second terminal from the cell to a terminal of the telephone. Then he connects the other terminal of the telephone with the metal rod of the sphygmograph which supports the talc. The instrument is now ready for use. It is placed on the pulse, in the ordinary way, and is adjusted, with the writing needle thrown back, until a good pulsating movement of the needle is secured. When the movement is in full action, the needle is thrown over to touch the platinum plate, which it traverses with each pulse-movement, and completes the connexion between the telephone and the battery. The needle, in passing over the metallic plate, causes a distinct series of sounds from the telephone, which correspond with the movements of the pulse. When all is neatly adjusted, the sounds heard are three in number, one long sound and two short, corresponding to the systolic push, the arterial recoil, and the valvular check. The sounds are singular, as

resembling the two words, "bother it." The sounds can be made very loud by increasing the battery power. This little instrument is not so good a recorder of the pulse as the sphygmograph, but it may be made very useful in a class, for illustrating to a large number of students, at one time, the movements of the natural pulse, and the variations which occur in disease.

City Notes.

Old Broad Street, May 28th, 1879.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The report of the directors of this Company for the half-year ended December 31st, 1878, states "The revenue for this period amounted to £65,096 15s. 11d.; the working expenses to £14,364 19s. 11d., leaving a balance of £50,731 16s. 0d.; to this is added £5,675 11s. 3d. brought forward from the year ended 30th June, 1878, making a total of £56,407 7s. 3d. After deducting Income Tax, £605 10s. 6d., there remains a balance of £55,801 16s. 9d. First and second interim dividends amounting to £32,500 have been distributed, leaving the sum of £23,301 16s. 9d. to be carried forward. The directors have the pleasure to report that the dispute with the Western and Brazilian Telegraph Company as to the division of traffic receipts, which was referred to at the last general meeting, has been adjusted. The several sections of the Company's cable continue in good working order." In a table of receipts appended we find the total for 1875 amounted to £129,395, for 1876, £130,938, for 1877, £132,702, and for 1878, £134,616. The reserve fund is £172,516 9s. 2d. At the meeting held on May 22nd at the Cannon Street Hotel, the Chairman (the Right Hon. Viscount Monck) in moving the adoption of the report said "that with regard to the receipts there had been a net increase of £655 over that of the corresponding half of last year; while both in London and at the various stations of the Company there had been a decrease in the working expenses. The meeting was one at which they only laid a statement of the affairs of the Company on the table, and no other business had to be transacted." Sir Thomas Fairbairn, Bart., seconded the motion, which was agreed to. The meeting terminated by a vote of thanks to the Chairman.

REUTER'S TELEGRAM COMPANY.—The report of the directors for the year ended 31st December last states that the net profits for this period, after payment of current charges and deducting rebate on unexpired subscription and bad debts, amount to £5,627, including £205 brought forward from the last account. The usual interim dividend of 2½ per cent. was paid in October last, and the directors now declare a further dividend of eight shillings per share, equal to 5 per cent., free of income tax, making a total distribution of 7½ per cent. for the year, and leaving a balance of £113 to be carried forward.

EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH COMPANY.—The directors are prepared to receive subscriptions for £450,000 part of £640,000, in £100 debentures to be issued at par, carrying 5 per cent. interest. The debentures are primarily secured by a subsidy of £32,400 per annum granted by the Governments of New South Wales and Victoria, under a contract with the Company, dated May 6, 1879, while the general revenue of the Company is also liable for the payment of interest and principal *pari passu*, with the debentures previously issued amounting altogether to £320,000. The debentures will be either "registered" or to "bearer," at the option of the alottee.

The following are the latest quotations of telegraphs:—Anglo-American, Limited, 55¼-56¼; Ditto, Preferred, 85-86; Ditto, Deferred, 27¼-28¼; Black Sea, Limited, —; Brazilian Submarine, Limited, 6⅞-7⅛; Cuba, Limited, 8¼-8¾; Cuba, Limited, 10 per cent. Preference, 15¼-16¼; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10½-11; Direct United States Cable, Limited, 1877, 10⅞-11⅛; Eastern, Limited, 7⅛-7½; Eastern, 6 per cent. Debentures repayable October, 1883, 104-107; Eastern 5 per cent. Debentures repayable August, 1878, 101-103; Eastern, 6 per cent. Preference, 11¾-12; Eastern Extension, Australasian and China Limited, 7⅛-7½; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 107-110; German Union Telegraph and Trust, 7¼-8; Globe Telegraph and Trust, Limited, 4¼-5¼; Globe, 6 per cent. Preference, 10¼-11½; Great Northern, 8¼-8¾; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 2¼-3; Mediterranean Extension, 8 per cent. Preference, 9-9½; Reuter's, Limited 9¼-10¼; Submarine, 220-230; Submarine Scrip, 1⅞-2⅛; West Coast of America, Limited, 1½-1¾; West India and Panama, Limited, 1½-1¾; Ditto, 6 per cent. First Preference 8-8¼; Ditto, ditto, Second Preference, 7½-7¾; Western and Brazilian, Limited, 3¼-3½; Ditto, 6 per cent. Debentures "A," 95-99, Ditto, ditto, ditto, "B," 88-93; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 112-116; Ditto, 6 per cent. Sterling Bonds, 103-105; Telegraph Construction and Maintenance, Limited, 30¼-30¾; Ditto, 6 per cent. Bonds, 107-109; Ditto, Second Bonus Trust Certificates, 2⅛-2¼; India Rubber Co., 11¼-11⅝; Ditto, 6 per cent. Debenture, 104-106.

TRAFFIC RECEIPTS.

Name of Co. with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,213,900.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£	£	£	£	£	£	£	£	£	£	£	£	£
April, 1879 ...	45,540	12,885	3,000	803	15,180	37,846	21,060	16,299	... ...	10,195	4,225	10,526	5,183
April, 1878 ...	42,520	10,367	2,940	746	10,000	32,210	21,753	19,463	... ...	9,543	2,125	9,511	5,319
Increase	3,020	2,518	60	157	5,180	5,636	... ...	... ...	... ...	652	2,100	1,015	... ...
Decrease	... ...	... ...	... ...	... ...	... ...	... ...	693	3,166	... ...	... ...	... ...	... ...	136

Receipts for March of "The West Coast of America Company," were £3,700 against £3,425 in the corresponding month of last year.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)